

What is Claimed is:

1. A method of making a magnetic tunnel junction device, comprising:

forming a magnetic tunnel junction stack;

forming an etch stop layer on the magnetic tunnel junction stack, the etch stop layer comprising a first electrically conductive material;

forming a first mask layer on the etch stop layer;

patterning the first mask layer;

forming a discrete magnetic tunnel junction stack by etching the magnetic tunnel junction stack;

forming a spacer layer on the discrete magnetic tunnel junction stack, the spacer layer comprising an electrically non-conductive material;

forming a spacer by anisotropically etching the spacer layer;

forming a dielectric layer over the discrete magnetic tunnel junction stack and the spacer;

planarizing the dielectric layer until the dielectric layer and the first mask layer form a substantially planar surface;

forming a self-aligned via by etching away the first mask layer;

depositing a second electrically conductive material on the dielectric layer and in the self-aligned via;

patterning the second electrically conductive material; and

forming a dual-damascene conductor by etching the second electrically conductive material.

2. The method as set forth in Claim 1, wherein the etching away the first mask layer comprises a plasma etch using an etch material comprising a gas containing fluorine.
3. The method as set forth in Claim 2, wherein the etch material further includes oxygen.
4. The method as set forth in Claim 1, wherein the etching of the first mask layer to form the self-aligned via comprises a wet etch using an etchant material including fluorine.
5. The method as set forth in Claim 1, wherein the depositing of the second electrically conductive material is continued until the second electrically conductive material completely fills in the self-aligned via and extends outward of the substantially planar surface by a predetermined distance.
6. The method as set forth in Claim 1, wherein the etching the first mask layer is continued until the first mask layer is completely dissolved and the self-aligned via extends to the etch stop layer.
7. The method as set forth in Claim 1, wherein the spacer layer is conformally deposited on the discrete magnetic tunnel junction stack.
8. The method as set forth in Claim 1, wherein the spacer layer comprises a material selected from the group consisting of silicon oxide and silicon nitride.
9. The method as set forth in Claim 1, wherein the anisotropically etching the spacer layer comprises a reactive ion etch.

10. The method as set forth in Claim 1, wherein after the forming of the self-aligned via, the discrete magnetic tunnel junction stack and the self-aligned via are not aligned relative to each other.

11. A method of making a magnetic tunnel junction device from a previously fabricated magnetic tunnel junction stack, comprising:

forming an etch stop layer on the magnetic tunnel junction stack, the etch stop layer comprising a first electrically conductive material;

forming a first mask layer on the etch stop layer;

patterning the first mask layer;

forming a discrete magnetic tunnel junction stack by etching the magnetic tunnel junction stack;

forming a spacer layer on the discrete magnetic tunnel junction stack, the spacer layer comprising an electrically non-conductive material;

forming a spacer by anisotropically etching the spacer layer;

forming a dielectric layer over the discrete magnetic tunnel junction stack and the spacer;

planarizing the dielectric layer until the dielectric layer and the first mask layer form a substantially planar surface;

forming a self-aligned via by etching away the first mask layer;

depositing a second electrically conductive material on the dielectric layer and in

the self-aligned via;

patterning the second electrically conductive material; and

forming a dual-damascene conductor by etching the second electrically conductive material.

12. The method as set forth in Claim 11, wherein the etching away the first mask layer comprises a plasma etch using an etch material comprising a gas containing fluorine.

13. The method as set forth in Claim 12, wherein the etch material further includes oxygen.

14. The method as set forth in Claim 11, wherein the etching of the first mask layer to form the self-aligned via comprises a wet etch using an etch material including fluorine.

15. The method as set forth in Claim 11, wherein the depositing of the second electrically conductive material is continued until the second electrically conductive material completely fills in the self-aligned via and extends outward of the substantially planar surface by a predetermined distance.

16. The method as set forth in Claim 11, wherein the etching the first mask layer is continued until the first mask layer is completely dissolved and the self-aligned via extends to the etch stop layer.

17. The method as set forth in Claim 11, wherein the spacer layer is conformally deposited on the discrete magnetic tunnel junction stack.

18. The method as set forth in Claim 11, wherein the spacer layer comprises a material selected from the group consisting of silicon oxide and silicon nitride.

19. The method as set forth in Claim 11, wherein the anisotropically etching the spacer layer comprises a reactive ion etch.

20. The method as set forth in Claim 11, wherein after the forming of the self-aligned via, the discrete magnetic tunnel junction stack and the self-aligned via are not aligned relative to each other.

21. A magnetic tunnel junction device, comprising:

a discrete magnetic tunnel junction stack including a top portion, a bottom portion, and a side portion;

an etch stop layer of a first electrically conductive material, the etch stop layer is in contact with the top portion;

an electrically non-conductive spacer in contact with the side portion;

a dielectric layer surrounding the spacer;

a self-aligned via positioned between the spacer and extending to the top portion;

a bottom conductor in electrical communication with the bottom portion; and

a dual-damascene conductor including a top conductor and a via, the via is in contact with the etch stop layer and is positioned in the self-aligned via, and the top conductor and the via are homogeneously formed with each other.

22. The magnetic tunnel junction device as set forth in Claim 21, wherein the first electrically conductive material for the etch stop layer is a material selected from the group consisting of aluminum and alloys of aluminum.

23. The magnetic tunnel junction device as set forth in Claim 21, wherein the dual-damascene conductor is made from a material selected from the group consisting of aluminum, alloys of aluminum, tungsten, alloys of tungsten, copper, and alloys of copper.

24. The magnetic tunnel junction device as set forth in Claim 21 and further comprising:

a plurality of the magnetic tunnel devices positioned in a plurality of rows and a plurality of columns of an array;

a plurality of row conductors that are aligned with a row direction of the array;
and

a plurality of column conductors that are aligned with a column direction of the array,

each of the plurality of the magnetic tunnel junction devices is positioned between an intersection of one of the row conductors with one of the column conductors,

wherein the plurality of row conductors comprises a selected one of the dual-damascene conductor or the bottom conductor, and

wherein the plurality of column conductors comprises a selected one of the dual-damascene conductor or the bottom conductor.

25. The magnetic tunnel junction device as set forth in Claim 24, wherein the array is a MRAM array.

26. A magnetic tunnel junction device, comprising:

a discrete magnetic tunnel junction stack including a plurality of thin film layers that include a data layer, a reference layer, and a tunnel barrier layer positioned between the data layer and the reference layer;

the plurality of thin film layers including a top portion, a bottom portion, and a side portion;

an etch stop layer of a first electrically conductive material, the etch stop layer is in contact with the top portion;

an electrically non-conductive spacer in contact with the side portion;

a dielectric layer surrounding the spacer;

a self-aligned via positioned between the spacer and extending to the top portion;

a bottom conductor in electrical communication with the bottom portion; and

a dual-damascene conductor including a top conductor and a via, the via is in contact with the etch stop layer and is positioned in the self-aligned via, and the top conductor and the via are homogeneously formed with each other.

27. The magnetic tunnel junction device as set forth in Claim 26, wherein the first electrically conductive material for the etch stop layer is a material selected from the group consisting of aluminum and alloys of aluminum.

28. The magnetic tunnel junction device as set forth in Claim 26, wherein the dual-damascene conductor is made from a material selected from the group consisting of aluminum, alloys of aluminum, tungsten, alloys of tungsten, copper, and alloys of copper.

29. The magnetic tunnel junction device as set forth in Claim 26, wherein the data layer is positioned at the top portion and the data layer is in contact with the etch stop layer.

30. The magnetic tunnel junction device as set forth in Claim 26, wherein the reference layer is positioned at the top portion and the reference layer is in contact with the etch stop layer.

31. The magnetic tunnel junction device as set forth in Claim 26, wherein the tunnel barrier layer is made from a dielectric material.

32. The magnetic tunnel junction device as set forth in Claim 26 and further comprising:

a plurality of the magnetic tunnel devices positioned in a plurality of rows and a plurality of columns of an array;

a plurality of row conductors that are aligned with a row direction of the array;
and

a plurality of column conductors that are aligned with a column direction of the array,

each of the plurality of the magnetic tunnel junction devices is positioned between an intersection of one of the row conductors with one of the column conductors,

wherein the plurality of row conductors comprises a selected one of the dual-damascene conductor or the bottom conductor, and

wherein the plurality of column conductors comprises a selected one of the dual-

damascene conductor or the bottom conductor.

33. The magnetic tunnel junction device as set forth in Claim 32, wherein the array is a MRAM array.

34. The magnetic tunnel junction device as set forth in Claim 32, wherein the tunnel barrier layer is made from a dielectric material.